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Elementary Preservice Teachers' Use of Science Notebooks

Judith Morrison, Washington State University TriCities

Abstract

In this study, elementary preservice teachers used science notebooks throughout their science methods course to write about all aspects of science and scientific inquiry. The views regarding the use of science notebooks were explored in order to determine the preservice teachers' attitudes and perceptions toward their use. The findings demonstrated that the preservice teachers involved became more relaxed in the way they used notebooks to communicate science understanding. They also came to see the notebooks as a valuable formative assessment tool.

The current reform documents, the *National Science Education Standards* (*NSES*) (National Research Council [NRC], 1996) and the *Benchmarks for Science Literacy* (American Association for the Advancement of Science [AAAS], 1993), have stressed the need for teachers who are able to guide students in conducting science investigations. Teachers are being encouraged to involve students in authentic scientific investigations and work with students on the processes of science rather than focusing narrowly on the laws, concepts, and theories of science (AAAS, 1993). As teachers begin to involve students in inquiry-based science investigations, the need for students to communicate their science learning in new ways has become evident. Many of the inquiry-based science curricula currently in use in the elementary grades (i.e., FOSS or STC science kits) recommend and provide information for teachers on the use of science notebooks in inquiry science teaching. In order for teachers to effectively use science notebooks, it is essential that they have had experiences using science notebooks themselves and understand the wide variety of strategies that may be implemented when using science notebooks in the classroom. In this study, elementary preservice teachers used science notebooks throughout their science methods course to write about all aspects of science and scientific inquiry. The views of these preservice teachers were explored in order to determine their attitudes and perceptions toward the use of science notebooks.

Theoretical Framework

Research (Hand**,** Prain, & Yore**,** 2001; Rivard, 1994) has shown that writing-to-learn in science has enhanced students' learning when teachers attend to curricular goals, learners' metacognitive knowledge, and the instructional environment. Therefore, if students are encouraged to communicate their understanding of concepts through science notebook writings, these science notebooks can be an effective strategy to help students learn science (Audet, Hickman, & Dobrynina, 1996; Fellows, 1994; Shepardson & Britsch, 1997). Science notebooks also allow teachers to "assess students' understanding and provide the feedback students need for improving their performance" (Ruiz-Primo, Li, & Shavelson, 2002, p. 24).

Science notebooks can be a valuable tool for both teachers and students to use to determine (1) prior knowledge and existing science ideas, (2) how conceptual understanding is being built, (3) procedural understanding, (4) mastery of curriculum goals, and (5) the ability to apply/transfer ideas to new context (Volkmann & Abell, 2003). Science notebooks may be described as a place where students record their questions, predictions, observations and descriptions of procedures, and, most importantly, new concepts they have learned. Science notebooks may incorporate diagrams, drawings, graphs, and tables. They contain information about the students' classroom experiences and "they imitate the journals that actual scientists use as they explore the world" (Hargrove & Nesbit, 2003, p. 3).

According to Klentschy and Molina-De La Torre (2004), science notebook writing may be a way for students to strengthen their language skills as they develop an understanding of the world around them.

> The student science notebook serves as an important link between science and literacy when it is utilized in the classroom as a knowledge-transforming form of writing that provides an appropriate opportunity for students to develop voice in the process of constructing meaning from their experiences with the science phenomena. This, coupled with appropriate and timely feedback from the classroom teacher, has strong potential to provide the improvement in student achievement across the curriculum that educators are seeking. (p. 352)

Science notebooks may be defined as individual, spiral, hardbound composition books or folded paper notebooks in which students formulate questions, make predictions, record and display data, analyze results, propose explanations, compose reflections, and communicate hypotheses during inquiry investigations. These notebooks are similar to research scientists' log books and students are encouraged to use them as scientists would: before, during, and after all investigations.

The research questions guiding this study were as follows:

- What are elementary preservice teachers' attitudes towards using science notebooks in their science methods course?
- How do preservice teachers plan to use science notebooks in their own future teaching?

Method

Participants

The preservice teachers involved in this study were enrolled in four separate undergraduate science methods courses, which were all similar in design. The courses were all taught by the author and included two courses in the fall semester of 2004 (20 students in each), the third course the following fall semester (16 students), and the fourth course the following spring semester (14 students). These 70 preservice teachers were generally in their last semester before student teaching, although a few in each class would not student teach until the second semester after the methods course. The preservice teachers had all been required to take at least two science courses as general education requirements for their elementary education degree. These science courses had most often been taken at a local community college and were most commonly a general geology or general

astronomy course. There were 61 females and 9 males in the group. The names of the participants have been changed to preserve anonymity.

Science Notebook Use

Throughout the semester-long science methods courses, the preservice teachers were required to maintain a science notebook. The methods courses were all similar, and the use of the science notebook remained consistent across all four courses. Preservice teachers were asked to provide either a hardbound composition book or a spiral bound notebook to be used for the science content parts of the methods course and not to be used for the pedagogy part of the course. During the second class meeting, the preservice teachers were given a short presentation on using science notebooks. Examples of scientists' notebooks were reviewed and discussed and recommendations were given on what to include in a science notebook. Typically, the last half of each class (1.5 hours) was spent making observations and predictions, collecting data, designing investigations, collecting and analyzing data, testing activities, formulating conclusions, and communicating conclusions and results. Any writing, diagramming, graphing, drawing, or concluding about these activities was done in the science notebook. The preservice teachers were also asked to reflect on activities they did and how they could be used in the classroom. The preservice teachers always worked in groups of three to four and compared and shared information from their science notebooks throughout their investigations. Often, the final communication was a group effort and involved combining the group's results. Collaboration among group members and between groups in the class was always encouraged. At the end of the class session, the preservice teachers were asked to review what they had written in their notebooks, reflecting on how it could have been clearer, how it demonstrated their learning, and how their learning might be assessed by the instruction based on their notebook writings and entries.

The preservice teachers also used their science notebooks for an individual inquiry investigation conducted on their own while outside of the science methods class. The assignment had five major required components: (1) at least one investigable inquiry question, (2) data collection for a minimum of six weeks, (3) evidence of data analysis and at least one graphic data display, (4) a conclusion or explanation based directly on the data collected, and (5) evidence of research conducted (i.e., websites, scientists, books) to support or refute conclusions made. For this assignment, the preservice teachers could choose one of the following four topics on which to conduct their inquiry investigations: (1) the weather, (2) the Moon, (3) invertebrates, or (4) plants. These topics were selected because they are general enough for most elementary preservice teachers to have some basic understanding of the science concepts involved, and these topics were common enough to not scare anyone off. These are also topics that many elementary teachers cover in science in grades K-5.

The science notebooks were viewed informally during every class session with oral feedback provided, and then they were collected for non-graded, formative assessment at the mid-semester point. At the end of the semester, the preservice teachers submitted their notebooks for both feedback and a final grade. The criteria for this final summative grade was presented to the preservice teachers at the start of the course in the course syllabus. The focus of the assessment was on the level of communication achieved, the degree of completeness and organization of the notebook, and the reflections provided by the preservice teachers on the activities and investigations in which they had been involved.

Data Collection

Science Notebooks

All the preservice teachers' writing in their science notebooks was read by the instructor as the science notebooks were graded throughout the science methods course. Any distinct comments made in the notebook writing regarding the use of notebooks or plans to use the notebooks were recorded in the researchers' notes. The individual inquiry investigation's final reflection was photocopied from each preservice teacher's notebook as well as samples from the writing done on classroom activities. Throughout the semester, exemplary science notebook work was photocopied, including drawings, charts, graphs, inquiry questions, inserts, conclusions, and reflections. Those that clearly communicated the intended concepts and demonstrated a science understanding were photocopied.

Written Assignments

The science methods course encompassed many science pedagogy topics. The assignments specific to science notebooks were a reflection paper (one to two pages) written on using science notebooks for formative assessment, a reflection paper written on the specific use of science notebooks in this science methods course, a rubric designed to assess science notebook work, and a final reflection on the individual inquiry investigation written in the science notebook.

Researcher's Log

The researcher (the science methods course instructor) kept a log where comments, questions, and impressions from the preservice teachers regarding science notebook use could be documented. Anything that was mentioned in class or via e-mail was collected for later use. Field notes taken during the class time when the preservice teachers were actively using science notebooks were also kept.

Data Analysis

Data were analyzed by analytic induction (Bogdan & Biklen, 1992). Patterns of similarities and differences in perspectives and approaches and any change in these perspectives were sought. The data were systematically organized and reduced using categories such as the following six examples: (1) use of science notebooks generally, (2) use of science notebooks as a formative assessment tool, (3) students' writing in science, (4) logistics of using science notebooks, (5) evidence of growth in preservice teachers' use of science notebooks, and (6) plans of future use of science notebooks. These categories were used to code and index participants' science notebooks, lesson plans, researcher's logs, individuals comments, and all other written work.

Findings

Attitudes Toward Using Science Notebooks

The preservice teachers were asked to reflect on their own use of science notebooks in the science methods course. Many of the preservice teachers said that they started out the semester viewing the science notebook as simply another

assignment and were often worried about making it neat and clean. Even though their grammar and punctuation were not graded, the preservice teachers were concerned about submitting a "nice looking" assignment. Some of the following quotes represent these views:

> *The science notebook started out as a way to present my learning to the instructor. As I began to write my reflections on the classroom inquiries, I realized this notebook could be a tool for me to refer to in the future as a teacher. So, I tried to use the reflections as a way to convey how the inquiries can be applied to a classroom.* (Cherie)

> *At first, I wanted everything in the notebook to be perfect, clean, and complete, and I labored over each page, writing carefully and adding drawings. That became too time consuming so I settled for less than perfect, which I'm sure a real scientist would have eventually done as well.* (Jan)

> *In the beginning, I was too concerned about making it too perfect. I was writing the information down on pieces of paper and then transferring it to my journal. A couple weeks of this proved to be too tedious, so I changed my strategy. I also started adding more diagrams and sketches. These strategies illustrated my observations and made them more beneficial to me in the future.* (Karin)

As evidenced by the quotes, the preservice teachers began moving away from the view that the science notebooks were just another assignment to be done for the instructor and moved towards using the notebook as a place where they could explore and document their own learning.

> *By the end of the semester, I was drawing more conclusions because throughout the activities, I tended to think of the results and procedures more thoroughly through all the experience I was gaining. I used my science notebook to assess myself by going back and seeing if I could understand what I was trying to communicate and also that I could follow the procedure.* (May)

> *[The science notebook] broadened and deepened my learning, especially the section used in class when small group discussion was taking place.* (Craig)

The preservice teachers considered the act of writing in the science notebooks to have a positive impact on their learning of science. The science notebooks also gave them a chance to collect both their thoughts and their information. When asked in a reflection paper to discuss the methods by which they would prefer to be assessed in the science methods course, many commented on their use of the science notebooks. Some of the more representative quotes were as follows:

> *Another idea I like that is currently being used is the science notebook. This provides me with documentation of the experiments that I am participating in during class and an opportunity to think about my own thinking by writing down my thoughts about the activity and what grade level they [sic] could be used for.* (Lana)

> *My science notebook contains thoughts or questions I may have about the content being taught in class or the concept being addressed in the experiment. By reviewing my science notebook, you have a better idea of what I understand and what I have conceptions or misconceptions about.* (Randi)

This method [science notebook] gives a great example of what I am understanding about a lesson and/or experiment right while I'm in the process of learning about it or doing it. I can use words, drawings, and graphs to get my point across. I can jot down my own impressions, while they are still fresh in my mind, for later analysis. Although a science notebook does need to have some level of organization, I don't have to commit the time I could be learning about the subject to being overly perfect with my entries. This method helps open up my creativity. (Coreen)

Preservice Teachers' Plans to Use Science Notebooks

When asked how they might use science notebooks in their own future teaching, the majority of the preservice teachers involved in this study stated that they would use science notebooks in their classroom. Many said that science notebooks would be a good place for students to document their science work: "I think it [science notebook] is a good way for students to keep track of tasks and a good way for students to expand on something"; "I will use the notebook by having students write down any predictions or investigations they have"; and "To help students with their thought processes, organization." In their written work on lesson plans, every preservice teacher said that they would have their students record some aspect of science inquiry (i.e., recording data, making predictions, designing investigations, proposing explanations, or communicating conclusions) in science notebooks and would then view the entries and provide feedback in some form or another.

Through their use of science notebooks and their instruction on formative assessment, the preservice teachers began to see science notebooks as a valid formative assessment tool. They saw the science notebooks as a tool to use to get an idea of students' comprehension: "You cannot only assess science understanding, but you can assess the writing"; "Great way to note progress, are they completing tasks, are they making conclusions and actually 'getting it'?"; and "I will be able to see if my students are putting thought into what they are doing." The preservice teachers said that they planned on using science notebooks as an assessment tool in their teaching: ". . . an assessment tool for students' understanding of concepts, as a journal, too, to reflect individual style with art and writing" and "You can certainly check for understanding and assess their experimental procedures."

Discussion and Conclusions

The preservice teachers involved in this project had to be immersed in the use of science notebooks before they were able to see the value of this tool in inquiry science. By simply telling these preservice teachers about science notebooks, they may never have come to realize that the notebooks could be used for formative assessment, a portfolio, and an organizational tool for students; they needed to become science notebook users themselves. Some of the preservice teachers had trouble at the beginning of each semester because they wanted to present their science notebook work in a "perfect format," which caused frustration and ultimately, a movement towards using science notebooks as a place to document their own ideas and learning without worrying about it staying clean or the grammar and punctuation. Without being asked to use science notebooks themselves, they may never have surmounted this struggle which, in turn, will allow them to better implement science notebooks with their own students.

When the preservice teachers shared their science notebook entries with others in their groups, they began to see that science is often a collaborative endeavor and that not everyone automatically comes to the same conclusion on a given set of data. The preservice teachers began to rely more and more on the science notebooks of the other members of their investigation groups as the semester progressed. Similar to Audet et al.'s (1996) finding that shared learning logs "cemented the interpersonal relationships found in the classroom" (p. 220), it was seen in this study that sharing science notebooks allowed the preservice teachers to strengthen their group relationships and view collaboration as an essential feature of doing science.

The combination of writing and doing inquiry science in the classroom is a natural and necessary step towards science literacy. As stated by Baxter, Bass, and Glasser (2001), the teacher must

> take an active role in making the writing process apparent, purposeful, and relevant. In this regard, engaging teachers in a discussion of current uses of writing in science, students' use compared to scientists' use of notebooks, variations in writing expectations across grade levels, and teacher and student perceptions of the purposes for notebook writing merits attention. (p. 139)

In this study, the preservice teachers began to write more about science and, thereby, came to see that science notebooks are a useful tool to use to communicate learning in science.

Recommendations

In order to encourage the use of science notebooks in elementary classrooms, it will be important to introduce teachers at both the preservice and inservice levels to the uses of science notebooks such as those recommended by Shepardson and Britsch (2000) and encourage teachers to employ science notebooks as part of their assessment program. Involving students in inquiry-based science learning requires that the teacher implement new strategies to assess students' science understanding such as science notebook writing. As shown through previous research (Morrison, 2005), when preservice teachers are provided clear instruction on using science notebooks as a formative assessment tool, they "see the value of the notebook as a window into students' thinking rather simply as a place to record data" (p. 18). It will be essential to spend time in science methods courses providing preservice teachers with experiences and instruction on assessment practices other than the summative methods stressed by federal policies. As stressed by Black (1998), the substantial rewards of formative assessment will only happen "relatively slowly, and through sustained programs of professional development and support" (p. 46).

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Correspondence regarding this article should be directed to

Dr. Judith Morrison
Washington State University TriCities
2710 University Drive
Richland, WA 99354
(509) 372-7176
Fax: (509) 372-7555
jmorriso@tricity.wsu.edu

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